STANDARD VALUE OF THE DE-BENDER GESTALT TEST (BGT) IN PRIMARY SCHOOL CHILDREN

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Synopsis : The purpose of this study is to establish a standard value for the DE-BGT in primary school children. This test was developed by the authors' research group as one of the screening tests for neurological disorders, such as mental retardation, epilepsy, and minimal brain dysfunction syndrome in children.

The BGT was originally standardized as an individual test to detect neuropsychiatric disorders in children and adults.

We simplified the original BGT to apply it to a group of children. In our simplified test, which was named the DE-BGT (DE : Developmental Epidemiology), one examiner gives the test to 45 (or less) children at the same time. In the original method, nine geometrical figures (designs) are given to the children to copy, whereas in the DE-BGT, only five are given. The dissimilarity of the copied figures from the original is evaluated according to 18 criteria. The time needed to evaluate the results is one or two minutes per child. The subjects of this study were 2,629 apparently normal children ranging from six to twelve years of age.

The developmental change of the average score and standard deviation by age and sex were obtained. Based on these data, "pass-nonpass criteria" by age and sex were established. For example, when the screening level is placed at the level where 93.3% of apparently normal school children pass, children getting a score of eight or more are judged as "non-pass."

The authors' research group are now studying the validity and reliability of this test which will be discussed in Part II of this paper.

Generally speaking, the simplified test can be used not only for screening, but also as an epidemiological tools to assess a population.

INTRODUCTION

The authors' research group has been proposing the "mass-neuro-pediatrics"(developmental neuro-epidemiolgy[1)~12)]). It handles various fields of study concerning neuro-pediatric disorders including the prevention. Therefore we consider that this "mass-neuro-pediatrics" may belong to the field of preventive medicine.

The authors' reseach group has positively adopted into our research the method of epidemiology which is often used in the field of preventive medicine. In this sense, mass-neuro- pediatrics can be called "developmental neuro-epidemiology."

Yamamoto[13)] defines that epidemiology is the science to find out the law concerning frequency and distribution

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of health phenomena in a population.

Based upon this definition the authors define that "developmental neuro-epidemiology" is one of the fields of neuropediatrics and its purpose is to find out the law of frequency and distribution concerning the neurologic developmental phenomena in a population of children.

The authors' research group has been studying mainly mass-neuro-pediatrics for a quarter century and has developed various kinds of simplified CNS function tests for children.

Through studying mass-neuro-pediatrics, the authors consider that the simple health indices have various functions as shown in Table 1. They have the function of serving not only as screening tests, but also as health indices of the population of children.

The original BGT[14)~16)] consists of nine simple designs, each of which is presented to the subject for him to draw on a sheet of paper. The test has considerable literature with respect to its use as a visuo-motor test and has been used as a diagnostic clinical tool. The test is to evaluate how the subject's reproductions deviate from the original designs. It has been reported by many researchers that the test is effective to screen the brain damaged children from the normal children. because the reproduction of brain damaged children show greater deviation. Therefore the BGT is known as one of the visuo-motor tests to determine the diagnosis and

Table 1 **Functions of Simple Health Indices (Simplified Tests)**

1. As individual indices.
   (1) As a screening test.
   (2) Occasionally usable as one of the items in diagnostic criteria of the clinical diagnosis.
   (3) If the result of a simple test is available in advance, simple health indices will improve efficiency of the clinical test administercd later.

1. As indices of the group.
   Example (1) Usable as a health index when searching thc causative factors of diseases in the epidemiological studies.
   Example (2) Usable as indices of the community child health diagnosis, school health diagnosis, and community diagnoses.
   Example (3) If mass-screening of a disease by means of simplified health indices is widely carried out, mild and atypical cases of the disease will be detected and consequently the analysis of clinical picture including symptomatology will be improved.
   Example (4) Promoting the studies of pediatrics efficiently.
      a) Usable as objective and simplified criteria for normal children.
      (The simplified test can be the screening test for selecting the normal control children.)
      b) Usable as an index to control the quality of the subjects.
      c) Promoting the developmental studies efficiently based upon a large scale population survey.

management of prognosis for the psycho-neurological patients.

We simplified the original BGT to apply it to a group of children. In our simplified test, which was named DE-BGT, one examiner gives the test to 45 (or less) children simultaneously. In the original method, nine designs are given to copy, whereas in the DE-BGT, only five are given. The dissimilarity of the copied figures from the original is evaluated according to 18 criteria. The time needed to evaluate the results is one or two minutes per child. The number of subjects in this study was 2,629 apparently normal children ranging from six to twelve years of age.

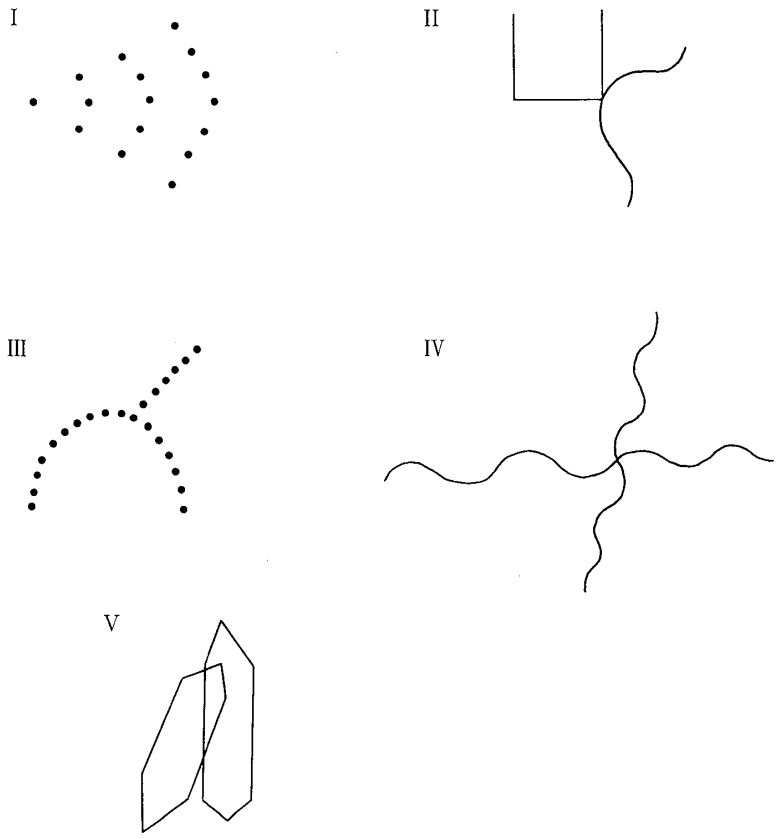


Fig.1 Five designs used in DE-BGT

1) DE-BGT (Developmental Epidemiolgic Bender Gestalt Test)

2) The original BGT consists of nine cards. Each card has a different design. The set of nine cards is published by Sankyo-bo in Kyoto, Japan. DE-BGT uses five designs out of the nine of the original BGT cards.

We have already established the standard value for high school students and adults.

This study aims to establish the standard value of DE-BGT in the population of primary school children.

SUBJECTS AND METHOD

Subjects in this study are mainly primary school children aged 6-12 as shown in Table 2. They are as follows : 2,247 primary school children, 239 kindergarteners aged 6, and 143 junior high school students aged 12. The total number of children is 2,629 (shown in table 3). The distribution by age of the subjects is balanced by adding kindergarteners and first year students of junior high school.

Table 2 **Subjects by age and sex**

Sex \ Age	6	7	8	9	10	11	12	Total
Boy	190	232	192	158	203	203	200	1378
Girl	157	208	186	172	185	178	165	1251
Total	347	440	378	330	388	381	365	2629

The locations of the above-mentioned schools are Mito City, Hokota Town, Kyowa Town, and Tone Town in Ibaraki Prefecture. The selection of subjects' schools is arbitrary, but qualitative deviation is avoided.

There are two kinds of methods in the clinical tests of the original BGT. One is for adults developed by G. R. Pascal and B. J. Suttell[17] ; the other is for children developed by E. M. Koppitz[18]. However these clinical tests are individual tests and they are impossible to be administered as a group test.

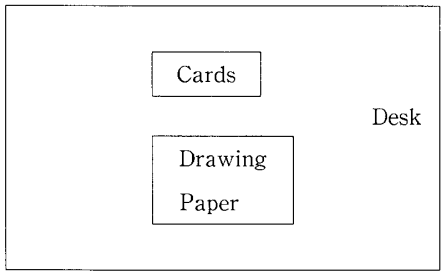
The authors simplified the BGT to apply it to a group of children. We tried very hard to simplify the original BGT's scoring items and its operation. We studied how to simplify each scoring criterion of this test, so that we could establish the validity and reliability of the DE-BGT as a group version for this test.

DE-BGT uses only five designs out of the original nine designs to screen the neurological disorders efficiently. There are too many scoring items in the original Pascal and Suttell scoring criteria whereas DE-BGT has only 18 scoring items. So now it is applicable for use with a population of primary school children.

How to administer the DE-BGT and scoring creteria are shown in detail in Table 3-1 and Table 3-2.

Table 3-1 **How to administer the DE-BGT**

1. One examiner can administer this test to about 45(or less) children at a time.
2. Before you give them the test, prepare the following things in advance : same number of pencils and erasers as that of children.
3. You place the DE-BGT cards and drawing paper on the desk (the picture shown below). The size of DE-BGT cards are the same as the original BGT cards, but the size of the drawing paper has been changed to size B5 (185㎜×257㎜). The stimuli cards are not necessarily in the original order(this is different from the original BGT). In the original BGT, the stimuli cards should not be rotated from the proper starting position, but in DE-BGT, a 180° rotation is allowed if desired(this is different from the original BGT).



Child

4. The examiner will usually give the following explanation. : (After the children fill their I.D.numbers, names, and grade in the blank section in the paper)

   "Now, we would like to know how skillfully you draw these designs (showing them to the children).
   There are five cards tied up together by a rubber band. Please take off the rubber band and put it on your wrist.
   Now, check the cards. Do you have five different cards? Each card has a different design. Is everything all right?
   You must draw each one of these designs to make five different pictures on this paper (showing the B5 paper).
   The cards must be set in their proper positions. The drawing paper can be used either horizontally or longitudinally, but once you start drawing the picture, do not change the position of the paper until you finish drawing.
   Use one side of the paper only. Do not use the back of the paper. Be careful to draw five pictures on this paper (showing the paper again). Do not copy the picture by putting your drawing paper on the card.
   Look at the card, and draw the picture as it is. When you make mistakes, you may use your eraser. Do not doodle on the cards. Do not stop drawing until you finish all five pictures.
   Draw the picture slowly and carefully. You may use as much time as you wish.
   Now, are you ready? Get set, go.
5. When the children ask you a question like this "Must we draw the same number of dots as in the picture? The following should be the answer :

   "Draw the picture as you see it."
6. When you collect the drawing papers, check whether the children have filled in their names, I.D. numbers and grade.
7. When the test is over, check if any cards are missing or if there is any doodling on the cards.

Table 3-2 **Scoring Manual of DE-BGT**

1. This test has 18 evaluating items by "number of failure counting system", therefore the highest score of 18 indicates the poorest record.
2. The differential judgement of dots, dashes, and circles in the design I, III.

   The following criteria are used to differentiate these.

a) circle: when the inside of circle is not printed completely, it is judged a "circle." Example (○ ◔ ◒ ○)

b) dash; 1.5mm or longer. Example (⁄ ⁄ ⁄ ⁄)

c) dot : In case of being neither a circle nor a dash, it is judged a dot. If a circle is completely painted like the example, it is also judged as a dot. Example (• • ● ●)

3. If you find the subject's reproduction missing even in one design among the five designs, it should be considered that the subject did not finish the test. A retest is required in the case.

Scoring manual of DE-BGT (Scorable deviation of each design and each item)

Design		Scoring item	Criteria of scorable deviation
I	1	Deviation of dots	When the dot deviated into circle or dash.
	2	Lack or extra number of dots	When there are more or less than 16 dots in the reproduction.
	3	Part of the design missing	When one of the rows is completely missing in the reproduction.
	4	Rotation	When the design is rotated more than 40° from its proper horizontal axis.
II	5	Asymmetry of the curve and square	The curve and the square are not joined : 1) when the peak of the curve is separated by 3mm from the adjacent corner of the square. 2) the curve not centered on the square or when the center of the curve and the lower right corner of the square do not coincide and bisection line may not be drawn.

Design		Scoring item	Criteria of scorable deviation
III	6	Design rotation	When the line bisecting the curve rotated less than 90° or more than 180°
	7	Deviation of the dot	When the dot deviates into cirle or dash.
	8	Number of the dots	When there are fewer than 5 dots in the extention and 15 dots in the curve.
	9	Distortion	When the design is markedly distorted from the original one or part of the design is missing.
	10	Rotation of the extention	The following items are scored : 1) when the extention begins at far below the approximate mid-dot of right side (less than 6 dots from the right end of the curve 2) when the direction of the extention is reversed to the left rather than to the right. 3) when the extention begins from the left of center.
IV	11	Double line or line missing	When there are double lines or part of the design is missing.
	12	Angles in the curve	When there is a distinct angle substituting for a curve.
	13	Curve extra	When there are more than five or less than two sinusoidal curves in either the horizontal or the vertical line
V	14	End of the lines	When the subject fails to join the ends of the lines forming the hexagons. (more than 1.5mm space between the lines).
	15	Double line	When there are differentiable double lines in the second attempt.
	16	Inaccurate angle	When the hexagon is markedly mal-formed.
	17	Rotation	When the lateral hexagon or the entire reproduction is rotated more than 40°.
	18	Distortion	When the two hexagons do not overlap or when they overlap excessively.

RESULTS AND DISCUSSION

Table 4 shows the distribution of the subjects by DE-BGT score, age, and sex. Mean score of girls was significantly lower than that of boys except in the ages of 9 and 10 ($P<0.05$).

Table 4 **The distribution of the subjects by DE-BGT score, age, and sex.**

age / sex / score	6		7		8		9		10		11		12	
	boy	girl	boy	girl	boy	girl	boy	girl	boy	girl	boy	girl	boy	girl
0				1	3	7	7	8	8	19	31	30	43	41
1 •			2	5	6	8	14	25	33	34	34	40	54	56
2	2	3	18	9	21	31	36	29	44	41	36	49	44	36
3	8	8	19	23	37	41	29	38	48	30	44	27	33	15
4	9	15	24	36	39	38	28	31	43	30	35	14	20	11
5	21	19	43	40	36	27	23	21	15	16	14	15	5	6
6	21	26	44	44	27	18	12	14	8	9	6	3	1	→1
7	30	28	27	24	16	7	7	3	4	4	3	→2	→1	
8	36	22	30	9	3	8	2	3	→1	2	→1		→1	→1
9	27	17	17	6	4	1								
10	16	12	6	9	→2		→1	→1						
11	14	4	2	2	→1									
12	4	2	→1	→2					→1	→1				
13	1	1												
14	1													
18														
Total	190	157	232	208	192	186	158	172	203	185	203	178	200	165
	347		440		378		330		388		388		365	
Average score	7.50	6.80	5.75	5.32	4.31	3.82	3.40	3.23	2.90	2.72	2.49	2.07	1.76	1.50
	7.18		5.55		4.07		3.31		2.81		2.29		1.64	

1) → Cases rejected by rejecting test.

2) Number of the subjects and average score by age and sex determined excluding rejected cases.

(DE-BGT has 18 evaluating items by "number of failure counting system," therefore the smaller number shows a better score).

Next, we examined also by the "Code Test," and the same result of significant difference of mean scores between boys and girls was found. Therefore the mean score tables are separately shown for boys and girls.

Table 5 shows the distribution of the boys in percentile by DE-BGT score and age.

Table 6 shows the distribution of the girls in percentile by DE-BGT score and age. The mean score and S. D. by age are also shown. The cases which showed greatly different scores are rejected by the Rejection Test. The rejected cases were 18 (10 cases in boys and 8 cases in girls). The number of the subjects and mean scores by age and sex were determined excluding the rejected cases.

Table 5 **The distribution of the boys in percentile by DE-BGT score and age.**

Age	6 n=190				7 n=232				8 n=192				9 n=158				10 n=203				11 n=203				12 n=200			
Score	F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile	
0									3	1.6	3	1.6	7	4.4	7	4.4	8	3.9	8	3.9	31	15.3	31	15.3	43	21.5	43	21.5
1					2	0.9	2	0.9	6	3.1	9	4.7	14	8.9	21	13.3	33	16.3	41	20.2	34	16.7	65	32.0	54	27.0	97	48.5
2	2	1.1	2	1.1	18	7.8	20	8.6	21	10.9	30	15.6	36	22.8	57	36.1	44	21.7	85	41.9	36	17.7	101	49.8	44	22.0	141	70.5
3	8	4.2	10	5.3	19	8.2	39	16.8	37	19.3	67	34.9	29	18.4	86	54.4	48	23.6	133	65.5	44	21.7	145	71.4	33	16.5	174	87.0
4	9	4.7	19	10.0	24	10.3	63	27.1	39	20.3	106	55.2	28	17.7	114	72.2	43	21.2	176	86.7	35	17.2	180	88.7	20	10.0	194	97.0
5	21	11.1	40	21.1	43	18.5	106	45.7	36	18.8	142	73.9	23	14.6	137	86.7	15	7.3	191	94.1	14	6.9	194	95.6	5	2.5	199	99.5
6	21	11.1	61	32.1	44	19.0	150	64.7	27	14.1	169	88.0	12	7.6	149	94.3	8	3.9	199	98.0	6	3.0	200	98.5	1	0.5	200	100.0
7	30	16.3	91	47.9	27	11.6	177	76.2	16	8.3	185	96.4	7	4.4	156	98.7	4	2.0	203	100.0	3	1.5	203	100.1	→1			
8	36	18.9	127	66.8	30	13.0	207	89.2	3	1.6	188	97.9	2	1.3	158	100.	→1				→1				→1			
9	27	14.2	154	81.1	17	7.3	224	96.6	4	2.1	192	100.0																
10	16	8.4	170	89.5	6	2.6	230	99.1	→2				→1															
11	14	7.4	184	96.8	2	0.9	232	100.0	→1																			
12	4	2.1	188	98.9	→1												→1											
13	1	0.5	189	95.5																								
14	1	0.5	190	100.0																								
18																												
Mean Score	7.50				5.75				4.31				3.40				2.90				2.49				1.76			
S. D	2.31				2.16				1.83				1.81				1.55				1.71				1.39			

F : Frequency AF : Accumulative Frequency

Table 6 **The distribution of the girls in percentile by DE-BGT score and age.**

Age	6 (n=157)				7 (n=208)				8 (n=180)				9 (n=172)				10 (n=185)				11 (n=178)				12 (n=161)			
Score	F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile		F and%		AF and%ile	
0					1	0.5	1	0.5	7	3.8	7	3.8	8	4.7	8	4.7	19	10.3	19	10.3	30	16.9	30	16.9	41	24.8	41	24.8
1					5	2.4	6	2.9	8	4.3	15	8.1	25	14.5	33	19.2	34	18.4	53	28.6	40	22.5	70	39.3	56	33.9	97	58.8
2	3	1.9	3	1.9	9	4.3	15	7.2	31	16.7	40	24.7	29	16.9	62	36.0	41	22.2	94	50.8	49	27.5	119	66.9	36	21.8	133	80.6
3	8	5.1	11	7.0	23	11.1	38	18.3	41	22.0	87	46.8	38	22.1	100	58.1	30	16.2	124	67.0	27	15.2	146	82.0	15	9.1	148	89.7
4	15	9.6	26	16.6	36	17.3	74	35.6	38	20.4	125	67.2	31	18.0	131	76.2	30	16.2	154	83.2	14	7.9	160	89.9	11	6.7	159	96.4
5	19	12.1	45	28.7	40	19.2	114	54.8	27	14.5	152	81.7	21	12.2	152	88.4	16	8.6	170	91.9	15	8.4	175	98.3	6	3.6	165	100.0
6	26	16.6	71	45.2	44	21.2	158	76.0	18	9.7	170	91.4	14	8.1	166	96.5	9	4.9	179	96.8	3	1.7	178	100.0	→1			
7	28	17.8	99	63.1	24	11.5	182	87.5	7	3.8	177	95.2	3	1.7	169	98.3	4	2.2	183	98.3	→2							
8	22	14.0	121	77.1	9	4.3	191	91.8	8	4.3	185	99.5	3	1.7	172	100.0	2	1.1	185	100.0					→1			
9	17	10.8	138	87.9	6	2.9	197	94.7	1	0.5	186	100.0																
10	12	7.6	150	95.5	9	4.3	206	99.0					→1															
11	4	2.5	154	98.1	2	1.0	208	100.0																				
12	2	1.3	156	99.4	→2												→1											
13	1	0.6	157	100.0																								
14																												
18																												
Mean Score	6.80				5.32				3.82				3.23				2.72				2.07				1.50			
S. D.	2.23				2.09				1.88				1.80				1.84				1.55				1.33			

F : Frequency AF : Accumulative Frequency

Fig. 2 shows the developmental change in mean score (and S. D.) of DE-BGT by sex. Since the lower score shows the better record, this figure indicates favorable development of children's CNS function according to age.

Table 7 shows standard value of DE-BGT for children by age. Changing percentages of false positive are shown when the screening level is shifted to various levels. "Pass-nonpass criteria" were established by age and sex. For example : when the screening level is placed at the level where Ca. 93.3% of apparently normal children pass, children getting a score of eight or more are judged as "nonpass."

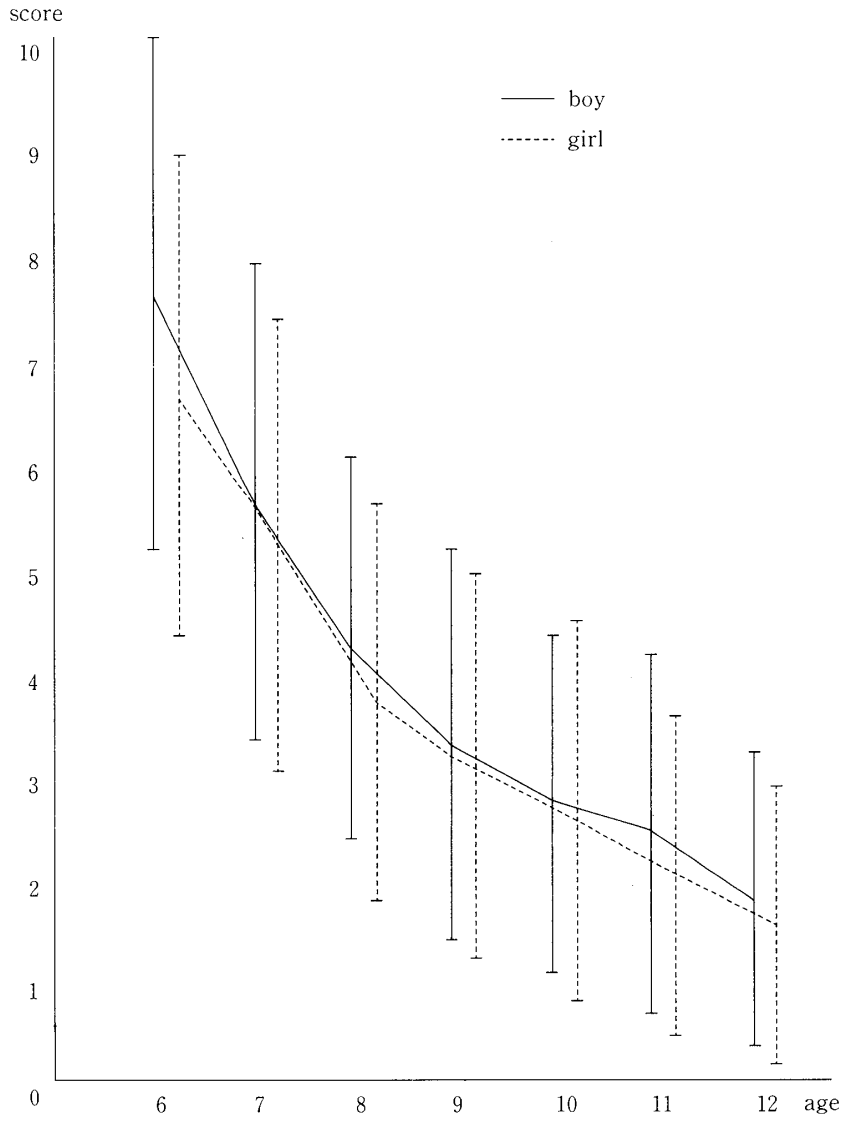


Fig.2. Developmental change of mean score (and S.D.) by sex.

The results of this study indicate that the DE-BGT is likely to be applicable to primary school children. The validity and reliablity of DE-BGT for primary school children will be examined in Part II in this study.

Table 7 **Standard Value of DE-BGT for children by age.**

—— Changing percentages of false positive when the screening level is shifted to various levels.——

	age / pass or nonpass screening level	6		7		8		9		10		11		12		Number of Nonpass among 1251 cases	False positive (T.V.)
		P	N	P	N	P	N	P	N	P	N	P	N	P	N		
Girl	50%ile (M+0S. D.)	6 or less	7 or more	5 or less	6 or more	3 or less	4 or more	3 or less	4 or more	2 or less	3 or more	1 or less	2 or more	1 or less	2 or more	618	49.4 (50.0)
	69.1%ile (M+0.5S. D.)	7	8	6	7	4	5	4	5	3	4	2	3	1	2	398	31.8 (30.9)
	84.1%ile (M+1.0S. D.)	9	10	7	8	5	6	5	6	4	5	3	4	2	3	194	15.5 (15.9)
	93.3%ile (M+1.5S. D.)	10	11	9	10	7	8	6	7	5	6	4	5	4	5	72	5.8 (6.7)
	97.7%ile (M+2.0S. D.)	11	12	10	11	8	9	7	8	6	7	5	6	4	5	24	1.9 (2.3)
Boy	50%ile (M+0S. D.)	7	8	5	6	4	5	3	4	2	3	2	3	1	2	1376 cases 704	51.2 (50.0)
	69.1%ile (M+0.5S. D.)	8	9	6	7	5	6	4	5	3	4	3	4	2	3	424	30.8 (30.9)
	84.1%ile (M+1.0S. D.)	9	10	8	9	6	7	5	6	4	5	4	5	3	4	179	13.0 (15.9)
	93.3%ile (M+1.5S. D.)	11	12	9	10	7	8	6	7	5	6	5	6	4	5	69	5.0 (6.7)
	97.7%ile (M+2.0S. D.)	11	12	9	10	8	9	7	8	6	7	6	7	4	5	31	2.3 (2.3)

M : Mean. S. D. : Standard Deviation. T. V. : Theoretical Value.

1.) When the screening level is placed at 84.1%ile (M+1.0 S. D.), false positive is 15.9%. Pass or Non-pass criteria being indicated in integral number of score, observed value of "false positive" rate is not equal to theoretical value shown in ( ).
2.) When you use DE-BGT as a screening test to screen neuro-developmental disorders, the screening level would better be placed at 93.3%ile (M+1.5 S. D.) or 97.7%ile (M+2.0 S. D.).

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